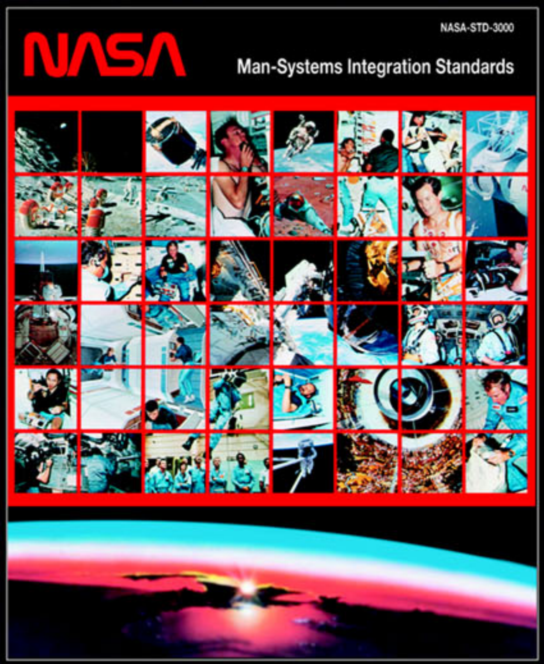
NASA Human Integration Design Handbook (HIDH)

Revitalization of Space-Related Human Factors, Environmental, and Habitability Data and Design Guidance



NASA-STD-3000
- Served as NASA's first human factors standard
- Specified how to design systems to support human health, safety, and productivity during space flight
- Was written primarily for the International Space Station

STANDARDS

NASA Space Flight Human System Standard

Volume 1

Crew Health

Office of the Chief Health and Medical Officer

Basic
November 2006

National Aeronautics and Space Administration

NASA Space Flight Human System Standard

Volume 2

Habitability and Environmental Health

Office of the Chief Health and Medical Officer

Basic
TBD

National Aeronautics and Space Administration

Space Flight Human System Standard
- Updates crew health and performance standards to apply to all future systems with human crews (spacecraft, landers, habitats, rovers, EVA suits, etc.)
- Requires that program specific requirements be derived from the standard with guidance from the HIDH

EXAMPLE:

"The vehicle / habitat atmosphere including pressure, humidity, temperature . . . shall be controlled in a manner that yields a healthy comfortable environment of respirable air to the crew"

These documents drive program -specific requirements

PROGRAM-SPECIFIC REQUIREMENTS

National Aeronautics and Space Administration

CxP 70024
REVISION A, CHANGE 001
RELEASE DATE: OCTOBER 30, 2007

CONSTELLATION PROGRAM
HUMAN-SYSTEMS INTEGRATION REQUIREMENTS

EXAMPLE:

"The system shall maintain the atmospheric temperature within the range of 18 °C (64.4 °F) to 27 °C (80.6 °F) during all nominal flight operations, excluding suited operations, ascent, entry, landing, and post landing."

HANDBOOK

NASA Human Integration Design Handbook (HIDH)

Office of the Chief Health and Medical Officer

Basic

In Work

National Aeronautics and Space Administration

EXAMPLE:
- Data on temperature effects on human physiology and performance
- Guidance for limits and implementation based on expertise, lessons learned

Human Integration Design Handbook (HIDH)
- Provides guidance and data to aid vehicle / habitat designers in human-system integration
- Aids requirements writers in development of human-system integration requirements from SFHSS Standards

Handbook Chapters include:
- Anthropometry And Biomechanics
- Human Performance Capabilities
- Natural And Induced Environments
- Architecture
- User Interfaces
- Hardware And Equipment
- Facility Management
- Health Management
- Extra-Vehicular Activity (EVA)

1.1 PURPOSE

The Human Integration Design Handbook (HIDH), NASA-HDBK-XXXX, provides guidance for the crew health, habitability, environment, and human factors design of all NASA human spaceflight programs and projects.

This handbook was created as a companion document to the NASA Space Flight Human Systems Standard (SFHSS), NASA-STD-3001. The SFHSS is a two-volume set of NASA Agency-level standards established by the Office of the Chief Health and Medical Officer that defines levels of acceptable crew health and performance risks resulting from spaceflight. Volume 1 of the SFHSS, Crew Health, sets standards related to crew health. Volume 2, Habitability and Environmental Health, defines the environmental, habitability, and human factors standards that are related to environmental health and human-system interfaces during human spaceflight.

The handbook serves as a guide for implementation of the high-level standards in the SFHSS. The handbook provides the information necessary to derive and implement program-specific requirements that are in compliance with the SFHSS.

The two primary uses for the handbook are to:
- Prepare contractual program-specific human interface requirements – Users include program managers and system requirement writers.
- Develop designs and operations for human interfaces in space vehicles / habitats -- Users include human factors practitioners, engineers and designers, crews and mission / flight controllers, and training and operations developers.

From 1987 through 2007, NASA-STD-3000, Manned Systems Integration Standards (MSIS) was the resource for data on humans in space. Much of this information has been updated and expanded for this handbook. The handbook was developed with consideration of all mission characteristics including gravity environment, mission duration, crew size, environmental factors, and suited operations. This document is now NASA's primary resource for information on humans in space. Unlike NASA-STD-3000, however, this handbook does not contain specific requirements that can be applied directly to a system design and development specification. Instead, it provides the data, guidance, processes, and constraints necessary to serve as a resource for building and implementing the appropriate human interface requirements for each specific program.

Pertinent data that is already documented in existing standards or documents (such as the Spacecraft Water Exposure Guidelines) will be referenced and documented in the Applicable Documents section of this handbook. Data that does not exist in a broadly published, consolidated form, will be carried directly in this handbook. Other standards will be referenced, but data pertinent to space flight missions will be consolidated and explained within this handbook.

5.5.4.3 Countermeasures for Rotational Acceleration

Rotational accelerations should not exceed 2 rad/s2. Rotational velocities in pitch and roll should not exceed the limits specified in Figure 5.3.3.2-1. These rotational limits apply for centers of rotation at the heart or outside the heart. However, for rotations outside the heart, the linear accelerations induced at the heart (by rotational accelerations and velocities) must be included in the linear accelerations, which are evaluated against the limits described in Section 5.3.3.1.

The data in this figure apply when crewmembers are appropriately trained and restrained and utilize G protection (Refer to paragraph 5.3.4). The figure presents three limiting conditions.

- The **solid red line** corresponds to maximum allowable rotation rates for automated crew abort/escape.
- The **dashed blue line** indicates the design limit for conditioned crewmembers during nominal ascent and entry.
- The **dotted green line** shows the design limit for long-duration, deconditioned, and/or ill and/or injured crewmembers.

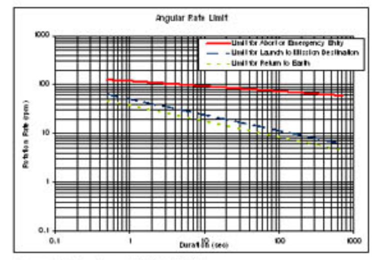


Figure 5.5-1 – Angular Rate Limit

Tolerance to rotational motion must be considered in terms of both rotational acceleration and rotational velocity. For vehicle occupants, the translational and angular motion must be assessed at each occupant's location in the vehicle. Also, the effects of the angular component of occupant motion will vary with superimposed linear acceleration.

5.2.2.2 Growth Trend

Past experience indicates historical changes in anthropometric dimensions such as height, weight, and other measurements. These changes that occur from generation to generation are referred to as secular change and the impact of such changes can be significant for hardware design.

In order to predict secular change, the first step is to estimate the stature of a future population based on trends. Next, a representative population or baseline database is selected. Body dimensions are then defined against the stature for each subject. Finally, the estimated future stature is used to calculate estimated future segment lengths and other dimensions based on the relationships between these dimensions and subject stature.

This procedure is followed through the following steps:
1. Select a population similar to the desired population that includes stature over several decades. Plot the average stature and determine a trend. Project the mean stature to the desired future date.

One source of growth trend data is published by the Center for Disease Control from their National Health and Nutrition Examination Surveys that they conduct approximately every 10 years. Figure 5.2-1 shows stature growth data for the American male. As can be seen, growth seems to be leveling off at 69.5 inches and a reasonable estimate of stature in 2015 would be 69.5 inches. The male astronaut population data (adapted from Air Force surveys) estimates the mean stature at 70.3 inches in 2015. This was the estimate used to create the data in the example tables in paragraph 5.2.1.

Figure 5.2-1 - Mean Male Stature Example

WE INVITE YOUR PARTICIPATION !

NASA-JSC HIDH development team has finalized the format and began developing section with subject matter experts.
Handbook expansion and maintenance is planned to assure its retention as a resource for human spaceflight.
If you are interested in participating in the writing, reviewing, enhancing of this document, contact any of the below:

Ken Stroud 281.483.5098, Lynn Pickett 281.483.6689, Barry Tillman 281.483.7131